Development of a Noninvasive Method for Measuring Thermophysical Parameters and Blood Perfusion of Living Tissues

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The measurement of thermophysical parameters and blood perfusion of living tissues is of fundamental importance for a variety of studies involving bioheat transfer and biomechanics. We have developed a noninvasive method for measuring the thermophysical parameters and blood perfusion of cylindrical living tissues. The only measurements required in this method are surface temperatures at three points along the axial direction of the tissue. By solving an inverse problem, this three-point method is capable of simultaneously measuring the thermal conductivity, volumetric thermal capacity, and blood perfusion of living tissues. Sensitivity analysis proves that all the three parameters would be estimated with high accuracy.

The three-point method has been validated by measuring tissue-equivalent phantoms with known thermophysical parameters and controlled blood perfusions. The experimental results of several series of practical measurements were found to be in good agreement with the known values. The average relative errors are less than 6 %. The three-point method has also been used to measure thermophysical parameters and blood perfusion of human forearms. The experimental results agreed with the literature values, within the reasonable parameter ranges of living tissues. The three-point method is therefore proven to be a very promising easy-to-use technique for simultaneously measuring multiple thermophysical parameters and blood perfusion of cylindrical living tissues with high accuracy.